Updated BFC for Level 3 Oceanic Rainfall Algorithm

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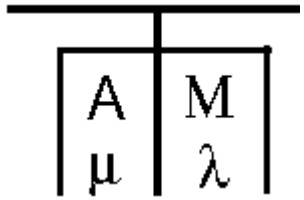
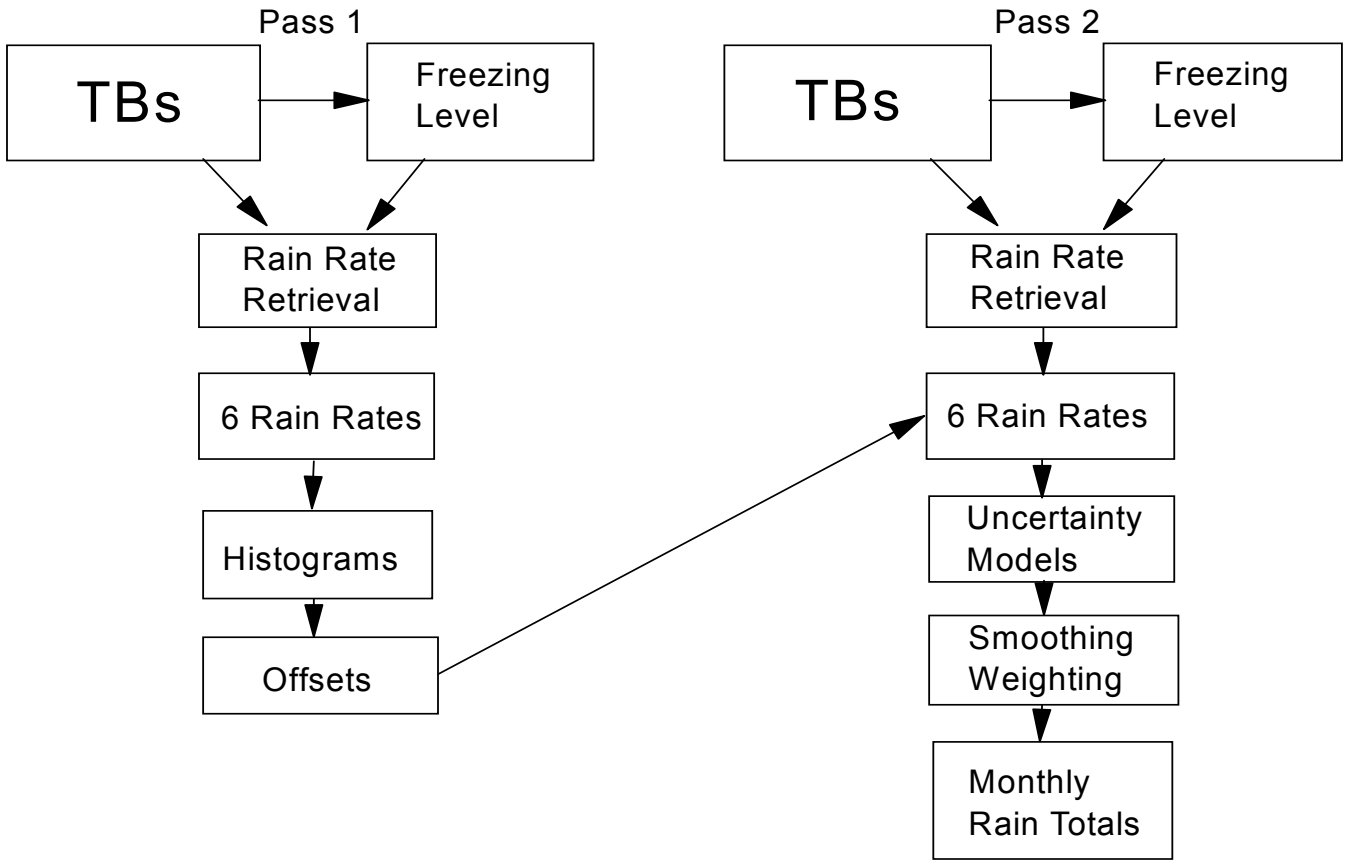
{Plus Numerous Collaborators and Students}



Two Pass Level 3 Oceanic Rainfall Algorithm



Beam Filling Correction Used in 3A11

Wang Used JPL Radar Data from NASA DC-8 A/C in TOGA/COARE

$$RR_{"true"} = C * RR_{fromTBs}$$

$$C = 1 + (0.478 * Log(\mathrm{Re}s(km)) - 0.687) / R_c$$

R_c Characteristic Rain Rate of Exponential TB Approximation

Res Longer 3dB Contour of Beam Spot

Chen Repeated Study with Kwajex Data

New Beam Filling Correction

"Use of the TRMM PR for Estimating the TMI Beam Filling Correction"

T.T. Wilheit and C. D. Kummerow

to be published in *Journal of the Meteorological Society of Japan*

19.35 GHz Pre Boost resolution only.

Used Resolution Dependence from Wang

Preliminary ResultsOnly

Some Scrubbing Necessary

TRMM Precipitation Radar Data for 1998

Profiles expressed as Surface Rain Rate & Slope

Surface Rain Is Desired Quantity but Column Mean is Closer to What the Radiometer Measures

Two Ways of Computing TBs

1) Compute TBs at Radar Resolution and Smooth to Radiometer Res

    Approximates Actual Measurement

1) Smooth Rain Field to Radiometer Resolution Then Compute TBs

    Implicit in Interpretation

    Don't Know Structure in General Case

    The Difference is the Beam Filling Error

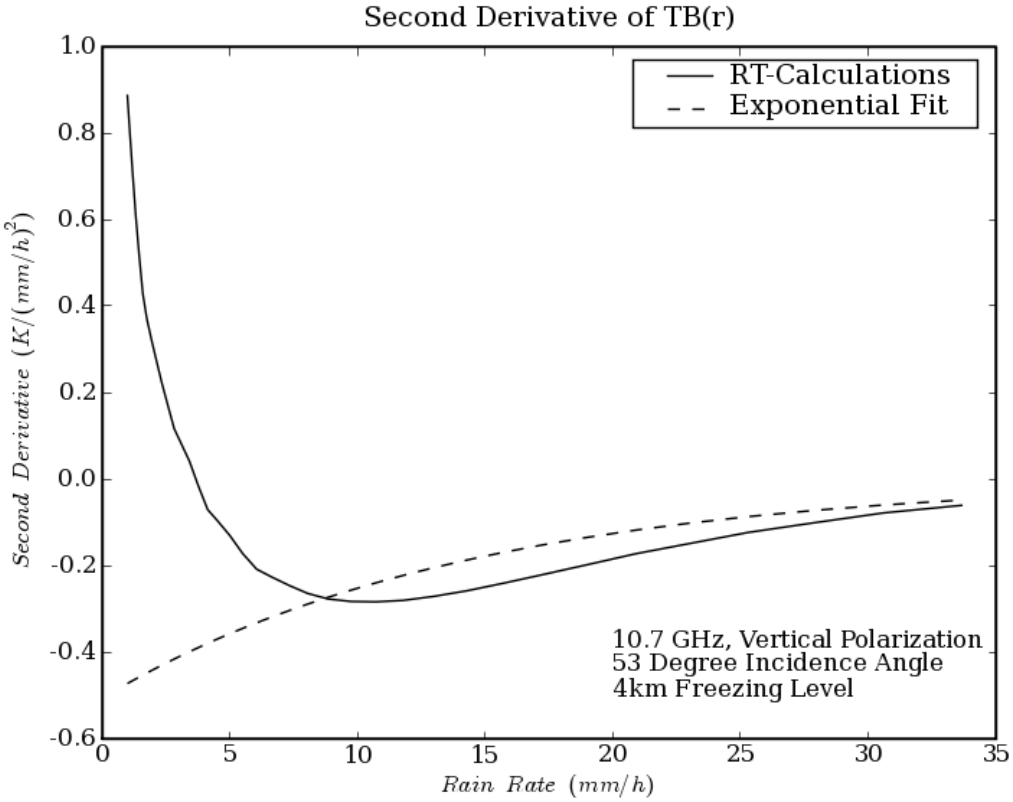
    Vertical Profile Error Remains

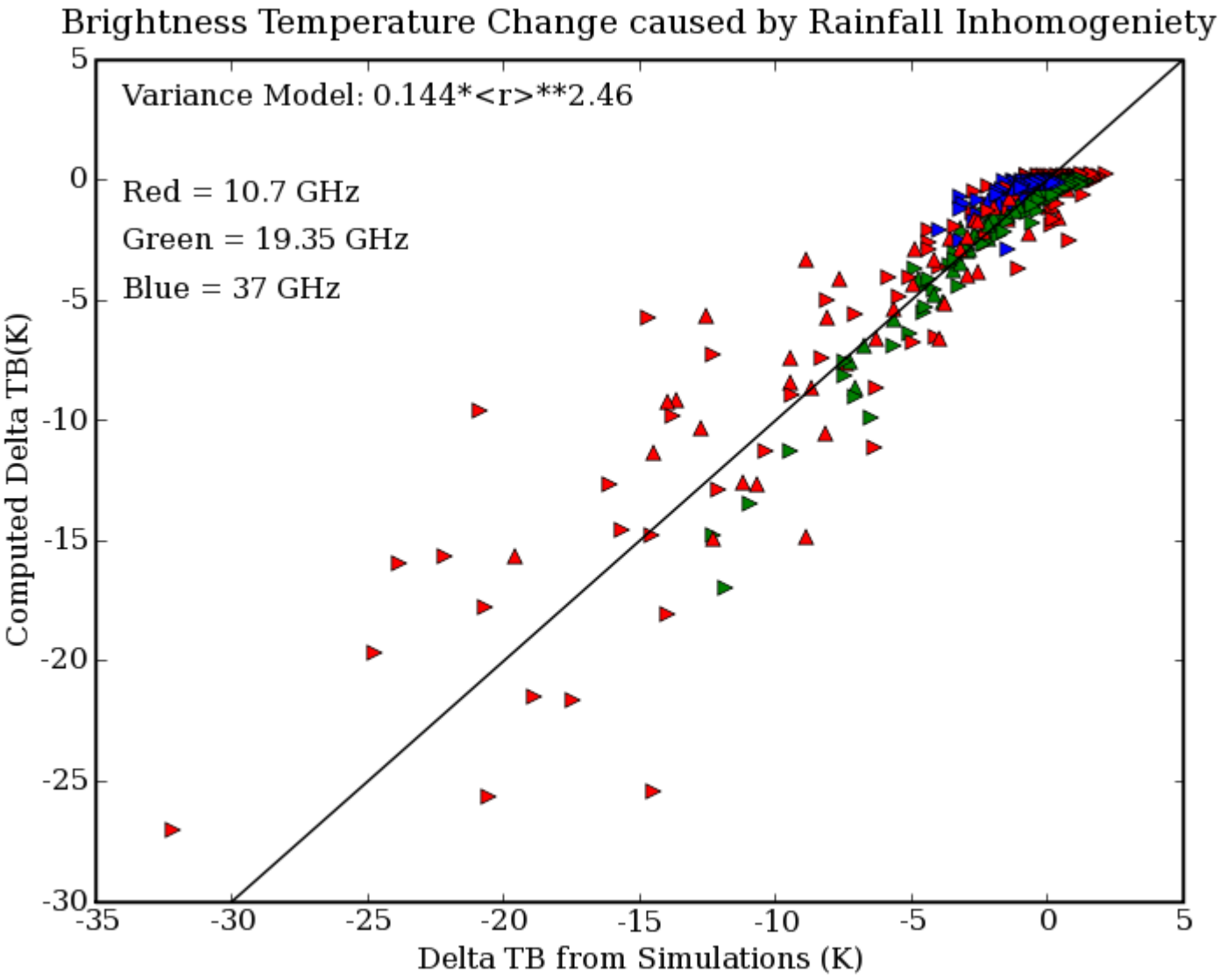
Can Only Be Corrected in a Statistical Sense

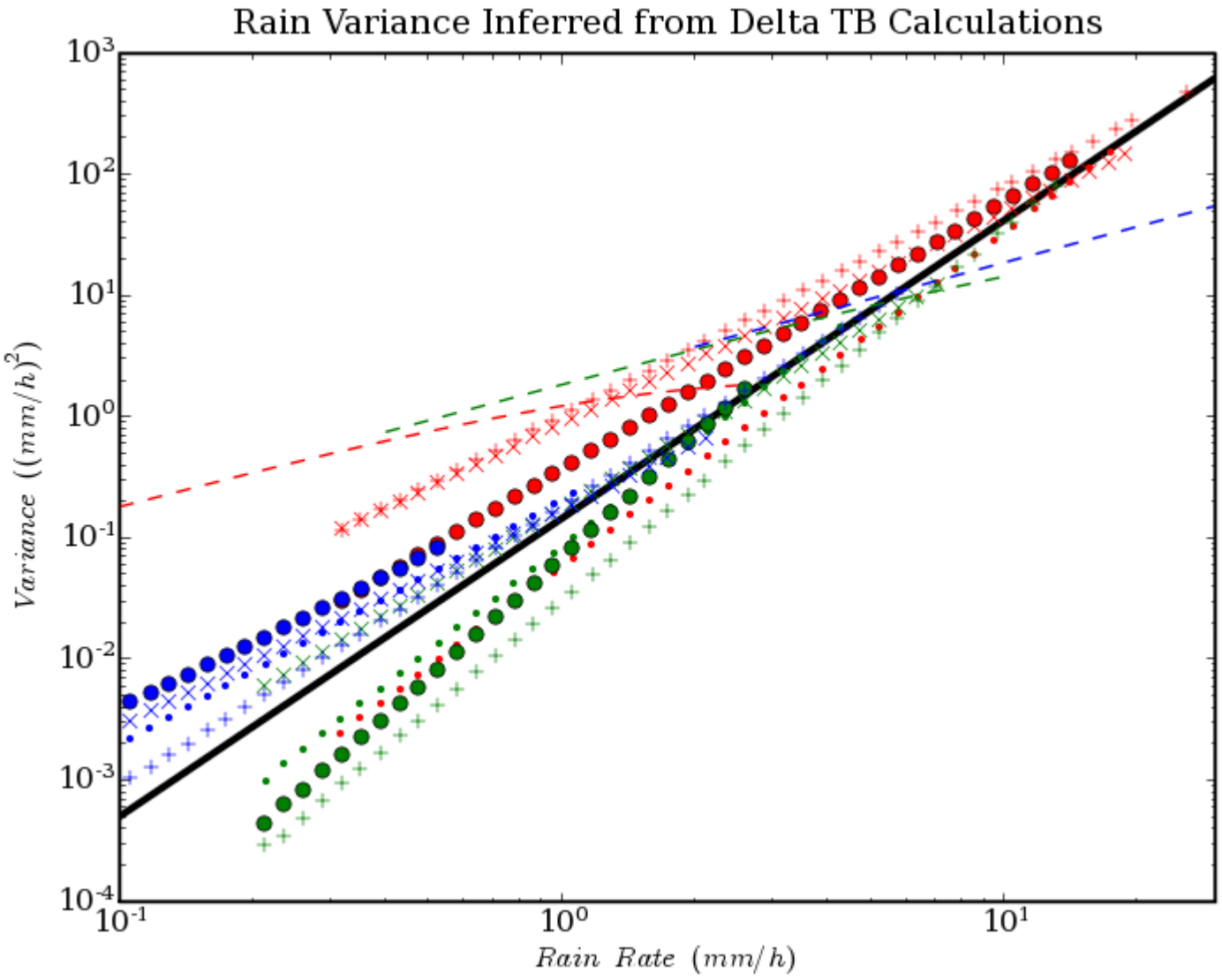
Expand Tb(RR) around <RR> (mean RR over FOV)

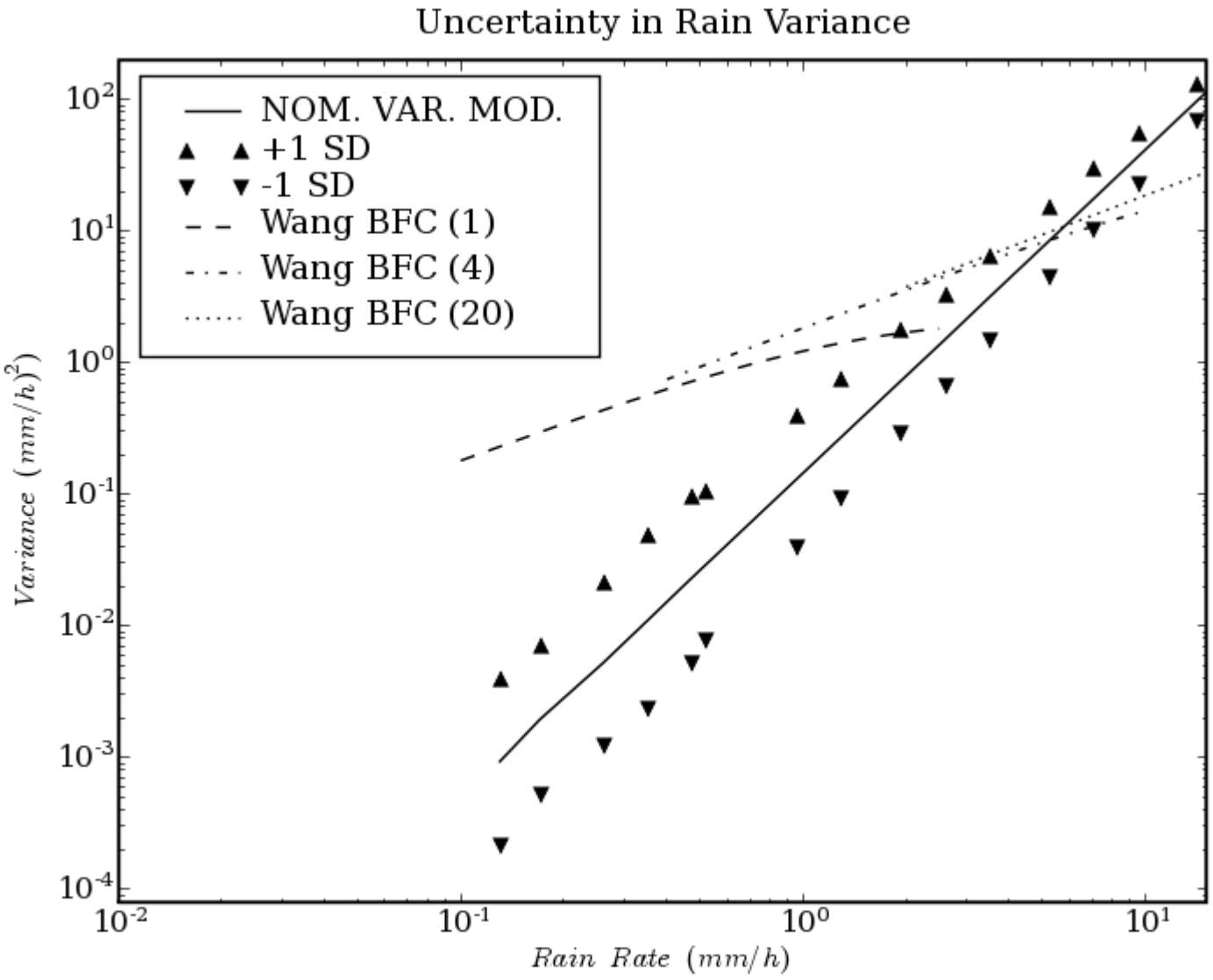
$$\Delta\ Tb \quad = \quad \frac{1}{2}\frac{\partial^{\ 2} Tb}{\partial\ RR^{\ 2}}\sigma_{RR}^{\ 2}$$

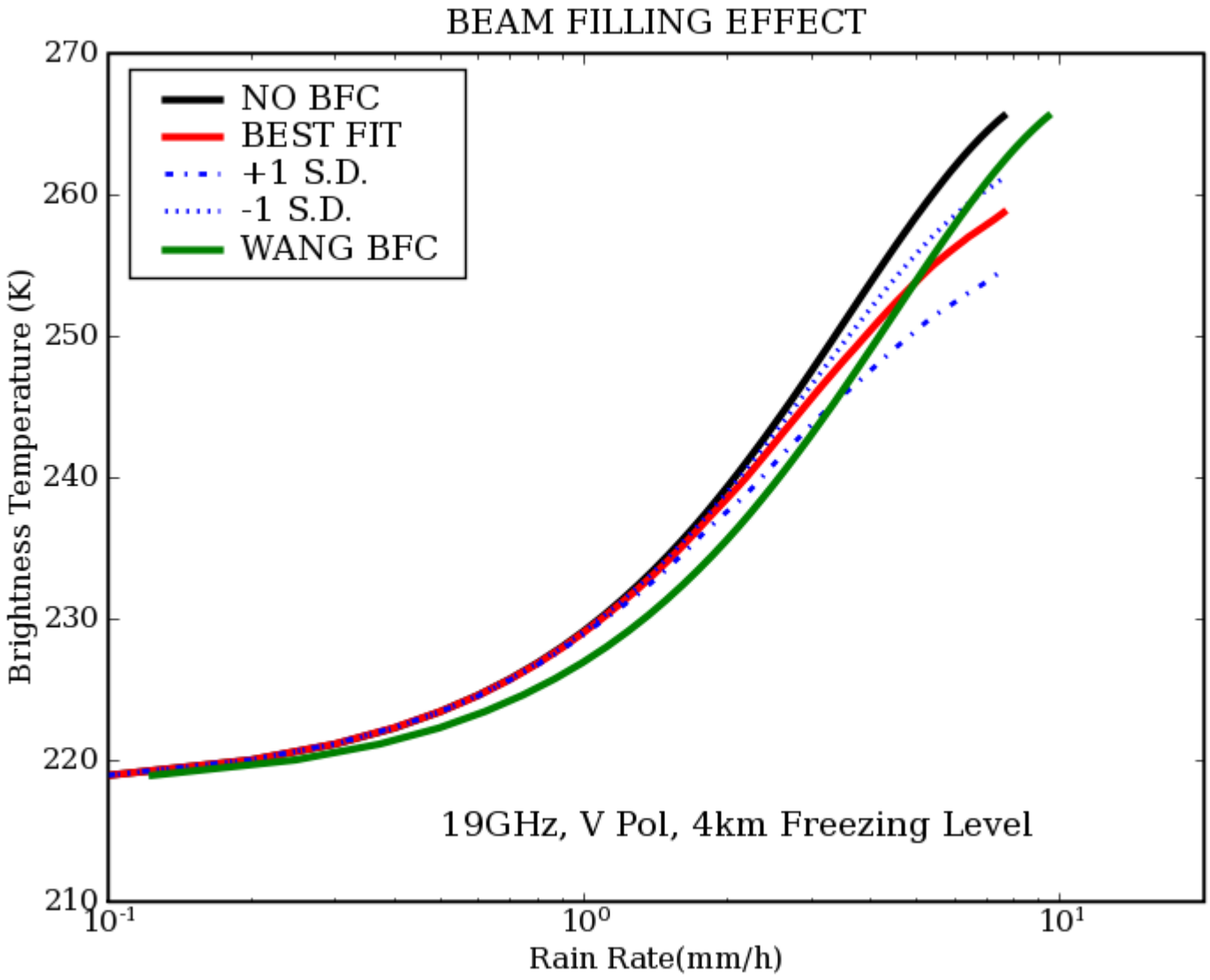
Thus, ΔTb Can be Expressed as $\sigma_{RR}^{\ 2}$ over FOV

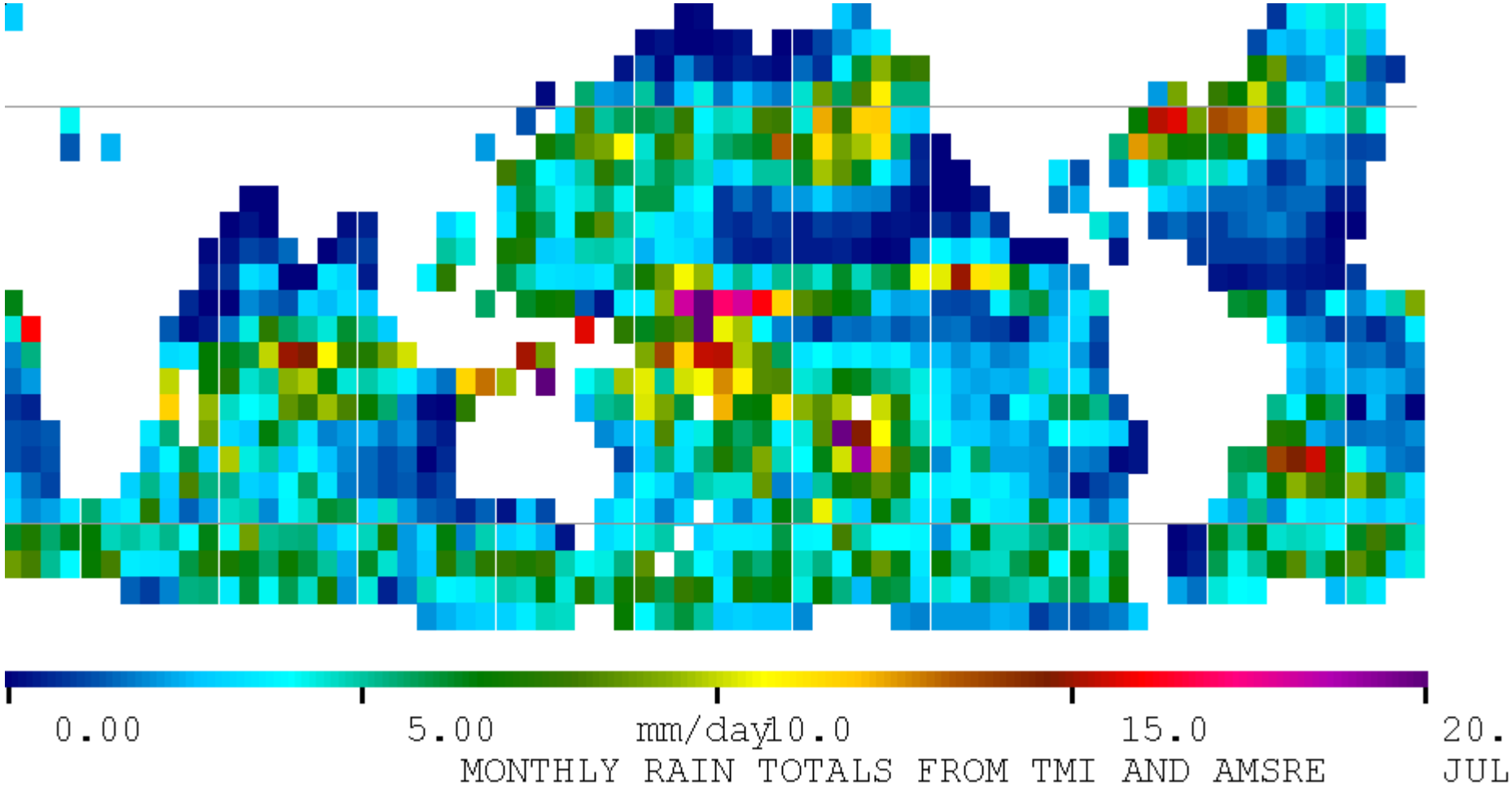

Second Derivative of TB(r)
RT-Calculations
Exponential Fit
10.7 GHz, Vertical Polarization
53 Degree Incidence Angle
4km Freezing Level
Second Derivative $(K/(mm/h)^2)$
Rain Rate (mm/h)
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
0
5
10
15
20
25
30
35

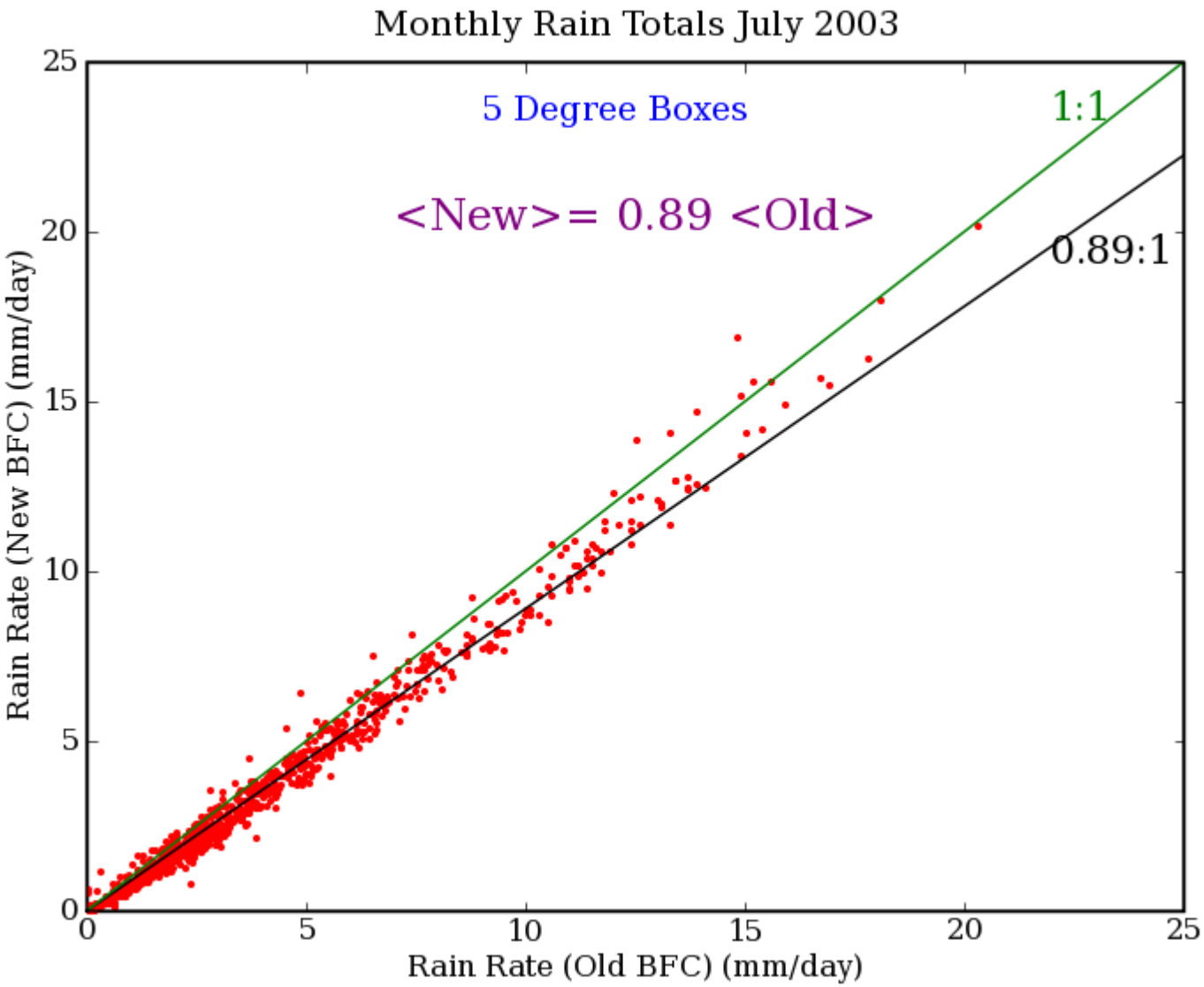

Brightness Temperature Change caused by Rainfall Inhomogeniety
Variance Model: 0.144*<r>**2.46
Red = 10.7 GHz
Green = 19.35 GHz
Blue = 37 GHz
Computed Delta TB(K)
Delta TB from Simulations (K)
5
0
-5
-10
-15
-20
-25
-30
-35
-30
-25
-20
-15
-10
-5
0
5

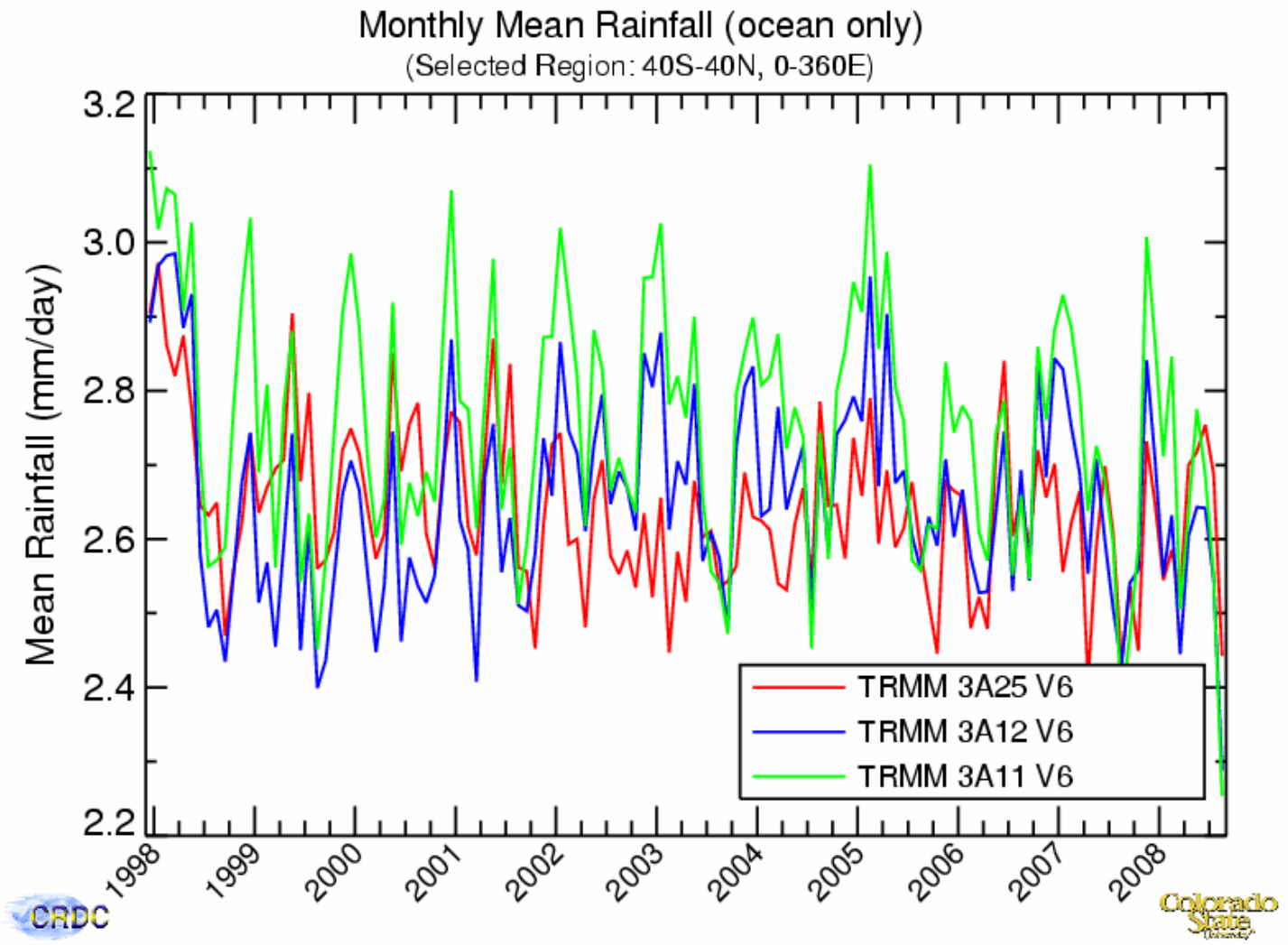

Rain Variance Inferred from Delta TB Calculations
10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-1}
10^0
10^1
Variance $((mm/h)^2)$
Rain Rate (mm/h)


Uncertainty in Rain Variance
NOM. VAR. MOD.
+1 SD
-1 SD
Wang BFC (1)
Wang BFC (4)
Wang BFC (20)
Variance $(mm/h)^2$
Rain Rate (mm/h)
10^{2}
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-2}
10^{-1}
10^{0}
10^{1}


BEAM FILLING EFFECT
NO BFC
BEST FIT
+1 S.D.
-1 S.D.
WANG BFC
19GHz, V Pol, 4km Freezing Level
Brightness Temperature (K)
Rain Rate(mm/h)
270
260
250
240
230
220
210
10^{-1}
10^{0}
10^{1}


0.00
5.00
mm/day
10.0
15.0
20.
MONTHLY RAIN TOTALS FROM TMI AND AMSRE
JUL


Monthly Rain Totals July 2003
5 Degree Boxes
1:1
<New>= 0.89 <Old>
0.89:1
Rain Rate (New BFC) (mm/day)
Rain Rate (Old BFC) (mm/day)
0
5
10
15
20
25


Monthly Mean Rainfall (ocean only)
(Selected Region: 40S-40N, 0-360E)
Mean Rainfall (mm/day)
3.2
3.0
2.8
2.6
2.4
2.2
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
TRMM 3A25 V6
TRMM 3A12 V6
TRMM 3A11 V6
CRDC
Colorado State

Conclusions

New BFC Reduces Mean Rain Rates by 11%

If Implemented in 3A11, Should Improve Agreement with Other Algorithms

Similar changes would be expected in AE Level 3 Oceanic Rain